PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Group:	1725	)
Attorney Docket:	12004	)
Applicant:	Cao *et al.*	)
Title:	Resistance Spot Welding Electrode	)
Serial No.:	10/634,020	)
Filed:	August 4, 2003	)
Examiner:	Tran, Len	)

Certificate Under 37 CFR § 1.10

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as First Class Mail in an envelope addressed to Assistant Commissioner for Patents, Washington, D.C. 20231

on 6/20/2005

Judy Readman

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ED 794591056 US

DECLARATION OF DR. PINGSHA DONG – 37 C.F.R. § 1.132

I, Dr. Pingsha Dong, 1330 Carron Drive, Columbus, Ohio 43220, United States of America, hereby declare:

1. I have read and understand the present Patent Application and the related Office Action mailed February 22, 2005.

2. I received Bachelor of Science (1978) and Master of Science (1980) degrees in Welding Engineering from the Harbin Institute of Technology, China and Master of Science (1984) and PhD (1989) degrees in Mechanical Engineering from the University of Michigan.

3. My broad experience encompasses a variety of welding-related research and development, including the development of novel welding/joining processes and the design and analysis of welded structures. From 1990 to 1994 I was progress from Senior Research Engineer, to Principle Research Engineer, and Section Manager at the Edison Welding Institute.

4. I am currently Research Leader with the Battelle Memorial Institute in Columbus, Ohio.

5. My specific welding-related expertise is in the areas of welding process modeling analysis of welded structures, large-scale computational methodologies, and finite element analysis of various aspects of structural performances.

6. Some specific examples of my work include studies of intelligent resistance welding processes, of weld strength mismatch effects on fracture behavior of welded structures,

development of weld acceptance criteria for welds containing porosity and micro-cracks, analysis of residual stress effects on fatigue behavior in welded structures, and residual stress and distortion control procedures in the fabrication of NASA's new super-light weight shuttle tanks.

7. I have published over 150 papers in scholarly journals and peer-reviewed conference proceedings and have offered numerous seminars and workshops for both industrial and academic audiences. Recent keynote lectures a major international conferences include: "Modeling and Analysis of Weld Residual Stresses In Al-Li Alloys", Fifth International Conference on Numerical Analysis of Weldability, Graz, Austria, October 1999; "Advanced Computational Modeling Techniques for Residual Stresses and Distortions In Welded Structures", The Sixth International Conference on Residual Stresses (ICRS-6), Oxford, England, July 2000; and "Residual Stresses and Distortions In Welded Structures: What We Know Today and Beyond", The Sixth International Conference on Trends In Welding Research, Pine Mountain, Georgia, April 2002.

8. In 2004, I received the Henry Ford II Distinguished Award for Excellence in Automotive Engineering for the most important engineering advance in 2003 from the Society of Automotive Engineers for my work in developing Verity, an accurate technique for predicting weld strength and fatigue life.

9. I have examined the prior art described in the Application as Fig. 2 and accompanying text as well as the related Nied reference cited in the Application (U.S. Pat. No. 4,514,612). As taught by Nied, an outer sleeve exhibiting high specific resistance, in combination with transverse thermal and electrical insulation provided by an insulating spacer, is able to channel welding current flow into the central region of the electrode. This vague assertion does not, however, go nearly far enough. The Finite Element Analyses ("FEA") presented in the Application, particularly those whose results are shown in Fig. 2 and described in the accompanying text, indicate that, due to inhibition of the current flow, the current densities are unusually high distal to the electrode face. This, in turn, results in lower temperatures at the electrode face and temperatures at the faying surface too low to effect a nugget.

10. While the larger sleeve shown in Fig. 2 in the Application produced excessively high current densities and failed to produce a nugget, it was surprisingly and unexpectedly found that thinner sleeves produced excellent nuggets. The attached figures illustrate the results of FEA done to investigate this phenomenon. The conditions were as follows:

Electrode diameter	6.4 mm
Aluminum sheet thickness	1 mm
Current	18 kA
Force	600 lbs
Sleeve material	stainless steel

Fig. 1 represents a sleeve thickness of 0.48 mm, or 15 percent of the outside radius.

Fig. 1a shows current density.

Fig. 1b shows the nugget produced (temperature) at five cycles. The diameter of the nugget is 4.3 mm.

Fig. 2 represents a sleeve thickness of 0.64 mm, or 20 percent of the outside radius.

Fig. 2a shows the current density.

Fig. 2b shows the nugget produced (temperature) at four cycles. The diameter of the nugget is 4.48 mm.

Fig. 3 represents a sleeve thickness of 0.8 mm, or 25 percent of the outside radius.

Fig. 3a shows the current density.

Fig. 3b shows the nugget produced (temperature) at four cycles. The diameter of the nugget is 4.32 mm.

Fig. 4 represents a sleeve thickness of 0.96 mm, or 30 percent of the outside radius.

Fig. 4a shows the current density.

Fig. 4b shows that the temperatures produced at four cycles are so high that the workpiece melts through to the surface. No effective nugget is produced.

Fig. 4c shows the nugget produced (temperature) at three cycles. The diameter of the nugget is 3.7 mm. This is unacceptably small.

11. In April 2004, our invention was tested by a major aluminum company. When they were first approached and our invention was described, they expressed skepticism that electrodes of such design would work. It was mainly as a personal favor to me that they even agreed to test our electrodes. Some of the results of their testing is shown in Table 1, below. The aluminum sheet was 2 mm 5182-O alloy. The composite electrode tested was configured as follows:

Electrode diameter	10.0 mm
Center insert diameter	4 mm, or 40 percent of the tip diameter.
Sleeve thickness	1 mm, or 20 percent of the outside radius.

The conventional electrode tested:

Face diameter	0.375 inch (9.5 mm)
Truncated	
Class 2	

Table 1

Electrode	Force	Cycles	kA (RMS)
Composite	1200 lbs	10	21.5
Conventional	1050 lbs	8	30.5

12. The conclusions drawn from these tests are that one can achieve about a 29.5 percent reduction in current and about a 37 percent reduction in energy (I^2t). Finally, as shown in attached Fig. 5, excellent nuggets are produced.

13. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: 7/20/05 By: [signature]
Pingsha Dong